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Evaluation of SCAT 02 Vehicles at EXPO 86

Prepared for
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by
Rutenberg Design Inc.

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EVALUATION OF SCAT 02 VEHICLES
AT EXPO 86

PREPARED FOR:
TRANSPORTATION DEVELOPMENT CENTRE
OF TRANSPORT CANADA

BY
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The contents of this report reflect the views of RUTENBERG DESIGN INC. and not necessarily the official views or opinions of the Transportation Development Centre of Transport Canada.

Un sommaire en français de ce rapport est inclus avant la Table des matières.

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17. Abstract This report describes the evaluation of three prototype electric vehicles used during Expo 86 to transport elderly and disabled visitors between the Skytrain transit station and the Canada Pavilion. SCAT (small carrier for alternative transfer) consists of a platform set on a low wheelbase, powered by three 12V batteries, and equipped with foldable seats, a wheelchair boarding ramp and tie-down system and a canopy for protection against the elements. The SCAT vehicles were operated during two six-hour periods, seven days a week for a total of 140 days during the fair. The vehicles transported an average of 180 mobility disabled passengers per day. The evaluation was based on data collected from drivers' logsheets, interviews with drivers and passengers, and videotapes of the vehicles in operation. After minor mechanical and electrical defects were corrected in the first few days of service, the vehicles experienced no further technical problems. The vehicles were favorably received by passengers, who considered them safe and comfortable, and by the drivers, who expressed satisfaction with the vehicle's easy handling and operation.			
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17. Résumé Ce rapport concerne l'évaluation des trois prototypes du véhicule électrique VITE qui ont servi durant Expo 86 au transport des personnes âgées ou handicapées, entre la station du Skytrain et le pavillon du Canada. Le VITE (véhicule intégré de transport électrique), mû par trois accumulateurs 12V, comporte une plate-forme très basse équipée de sièges repliables, une rampe d'accès, un dispositif d'immobilisation des fauteuils roulants et un toit protecteur contre les intempéries. Ces véhicules ont fonctionné pendant deux périodes de six heures tous les jours de la semaine pour un grand total de 140 jours. Ils ont transporté 180 personnes en moyenne par jour. L'évaluation a été faite à partir des données inscrites sur le carnet de bord de chaque véhicule, d'interviews personnelles auprès des conducteurs et des passagers et d'enregistrements vidéo des véhicules en marche. Les légers défauts électromécaniques ayant été corrigés au cours des premiers jours de service, les véhicules n'ont connu aucun ennui technique par la suite. Ils ont été bien accueillis par les passagers qui les ont trouvés sûrs et confortables, et par les conducteurs qui les ont trouvés agréables et faciles à manoeuvrer.			
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SUMMARY

Background

In April 1985, representatives of the Planning and Development Department of the Canada Pavillion at Expo 86 requested the technical assistance of the Transportation Development Centre (TDC) in identifying a suitable vehicle for a shuttle service for elderly and disabled visitors during Expo 86. Technical, user, operational requirements were established, and the development and deployment of three electric motor units, two trailers, and two charger stations were commissioned to RUTENBERG DESIGN INC. of Montreal.

An on-site performance study was requested by TDC to evaluate the technical performance of the prototype vehicles. The purpose of the study was to analyze driver, passenger, and service data.

Method

The evaluation was carried out during Expo 86 (May - September 1986) in Vancouver. Data was collected from the drivers' daily logsheets, questionnaire filled out by passengers and drivers, interviews with passengers and drivers, and from videotapes of the vehicles in operation.

The following aspects were to be evaluated:

1. Systems operation
2. Technical performance
3. Driving/boarding
4. Battery charging
5. Maintenance/service
6. Passenger safety and comfort

Systems Operation

Of four proposed routes, two were selected: the West Promenade and Cordova Street. Each route was to be serviced by one motorized SCAT unit and one trailer, with the third motor unit to be used as a spare. By the first week of operation, the West Promenade route had to be abandoned due to severe pathway congestion. Similarly, because of the heavy concentration of pedestrian and road traffic on the site, the trailers could not be used. The vehicles and the chargers were kept at the north end of the East Promenade.

An average of 180 mobility disabled passengers a day were transported by the SCAT vehicles. A much greater number could have been transported had the Operations Department of the Canada Pavilion provided the information facilities, such as signs and advertisements necessary to promote the SCAT service.

Technical Performance

The vehicles were powered by a 36-volt DC system, using three 12 V deep cycle batteries. Because of its proven performance on golf carts, a resistor coil system was chosen for speed control. Two drum brakes were located on the rear wheels. The steering ratio was 2:1. During the first few days, several problems occurred, such as a short circuit in the steering housing, a loose bracket on the rear axle, an inadequate charge of the batteries; but these problems were quickly remedied. A fully charged SCAT vehicle was used for 6 - 8 hours at a time, including pauses for loading, unloading, and waiting for passengers to arrive. A maximum speed of 20 km/h for an empty vehicle was safe on roads but too fast on walkways. All vehicles had licence plates, brake lights, and a horn. To save battery power, the SCAT vehicles had no running lights. The overall technical performance was considered to be very satisfactory.

Driving/Boarding

Each of the three specially trained SCAT drivers worked a six-hour shift. Their duties consisted of waiting for potential passengers at the pick-up points, assisting them in boarding, and driving the vehicle safely along the prescribed routes. The three young male drivers were physically capable of tilting the wheelchairs backward and pulling them up the ramp onto the vehicle. Measuring between 5'10" and 6'1" in height, the drivers had no difficulties with visibility, seat height, the reach for hand and foot controls, or deploying the ramp and tie-down. This was not the case for a 5'4" female supervisor who had difficulty reaching the foot controls and boarding a wheelchair passenger during a training session. An adjustable seat would solve the problem of reach.

Handling of the forward/reverse control lever was reported to have sometimes interfered with the passenger in the front seat. All drivers found steering, braking, parking and reversing to be effortless. In general, the drivers reported no difficulties in handling the vehicles and showed great care in boarding and debarking passengers.

Battery Charging

Two heavy-duty charger stations with a 25 A /36 V output were installed outside the north end of the East Promenade, where the vehicles were parked when not in use. Installing charger units outdoors is not recommended by manufacturers because of humidity and condensation. In this case, however, there was no alternative. The chargers were placed at the working height of 1.20 m (4'), for easy access by the drivers. To charge his vehicle, a driver would insert a bright yellow plug from the charger cable into the vehicle, unlock a small panel on the charger, and set a pivoting timer control to a maximum of 12 hours. A red light would go on and a buzzer would sound to

indicate that the charger was in operation. The process was simple, and no problems in handling were reported apart from a single incident when a driver drove off without disconnecting the cord. Adding a safety switch to the main key switch would prevent such a problem.

Maintenance/Service

A service contract had been arranged with a local maintenance specialist but, due to administrative difficulties with the Operations Department, the exhibition staff of the Canada Pavilion agreed to take over vehicle maintenance in June. Little maintenance was required. Access to the batteries was gained by simply unlocking three rubber snaps and removing the housing. All major parts and components were found reliable, except for one electronic battery charge indicator, which was replaced. After some repairs had been done, it was suggested that accessibility to the drivetrain and brakes and the steering housing, which contains switches and controls, be improved. It was also recommended that the front and rear skirts be easily removable to facilitate servicing.

Passenger Safety and Comfort

Visitors were picked up and dropped off at the waterfront station and at the main gate. A typical one-way ride, including boarding and disembarking, took from 4 to 6 minutes.

Wheelchair users felt very safe and comfortable boarding the SCAT vehicle because they could immediately assess the ease with which they would be wheeled up the ramp. Their feeling of security was augmented by the wheelchair tie-down and the ramp which was folded up after boarding operations to serve as a safety gate. Many passengers recommended that the service be extended throughout the fairgrounds.

Other mobility impaired passengers accessed the vehicle from the opposite side, over a 15 cm (6") step. The low height of the step was appreciated by passengers with canes and crutches, and by the elderly. They also appreciated the armrest which served not only as a support during the trip, but also as a secure hand grip for boarding and debarking. The rippled floor mat provided a safe standing surface even when wet.

Since the travel time was short, the lightweight open-steel mesh material used for the seats caused no discomfort. In addition, the canopy was welcomed as a protection against the elements.

CONCLUSION

The overall results of the evaluation proved that the SCAT vehicles provide a sound and dignified means of transporting mobility impaired people. Room for improvement exists in many areas, and many of the changes will depend on the specific application of these vehicles. Further application of the SCAT vehicles can easily be seen both outdoors and indoors.

SOMMAIRE

Rappel

En avril 1985, les responsables du pavillon du Canada à EXPO 86 ont demandé au Centre de développement des transports (CDT) de les aider dans leur recherche d'un véhicule pour le transport des personnes âgées et des handicapés. Ils ont défini les exigences techniques et d'exploitation ainsi que celles des usagers et ont confié à la firme montréalaise RUTENBERG DESIGN INC. la mise au point et la mise en service de trois unités motrices, deux remorques et deux postes de recharge.

Pour sa part, le CDT a demandé que l'évaluation technique des prototypes se fasse sur place; cette évaluation visait à analyser les données portant sur les conducteurs, les passagers et les conditions de service.

Mode opératoire

L'évaluation a donc été faite durant EXPO 86, qui s'est tenue à Vancouver, de mai à septembre 1986, à partir des données inscrites sur le carnet de bord de chaque véhicule, d'interviews personnelles auprès des conducteurs et des passagers, de questionnaires remplis par ces derniers et d'enregistrements vidéo des véhicules en marche.

Les aspects particuliers étudiés étaient les suivants:

1. mode d'exploitation,
2. performances,
3. procédures de montée et de conduite,
4. recharge des batteries,
5. entretien,
6. confort et sécurité des passagers.

Mode d'exploitation

Des quatre itinéraires envisagés, deux ont été retenus, soit la promenade Ouest et la rue Cordova, chacun devant être desservi par une unité motrice tirant une remorque, la troisième motrice servant de secours. Dès la première semaine, la promenade Ouest a dû être abandonnée à cause de la grande affluence; il a également fallu se défaire de la remorque, la circulation automobile et piétonnière étant trop intense. Les postes de recharge ont été placés à l'extrémité nord de la promenade Est.

Chaque véhicule a transporté en moyenne 180 passagers par jour. Ce nombre aurait pu être beaucoup plus élevé si le service Exploitation du pavillon du Canada avait fait une promotion plus complète du service offert: implantation de kiosques d'information, signalisation, panneaux publicitaires, etc.

Performances

Les motrices étaient mues par un moteur électrique alimenté par une batterie 36 volts formée de trois accumulateurs 12 volts à décharge profonde. Pour le réglage de la vitesse, un système à rhéostat a été choisi à cause de sa bonne tenue sur les voiturettes de golf. Les roues arrière ont été équipées de freins à tambour. Le rapport de démultiplication de la direction a été de 2:1. Au début, quelques ennuis techniques ont été notés: court-circuit dans le carter de direction, support de pont arrière desserré, recharge insuffisante de la batterie, mais tous ont été rapidement éliminés. Une batterie convenablement chargée pouvait fonctionner de six à huit heures, y compris les temps de pause, de montée et de descente. Quand le véhicule roulait à vide, la vitesse maximale de 20 km/h était sécuritaire sur la route, mais dangereuse sur les trottoirs. Les véhicules, dûment immatriculés, étaient munis de feux d'arrêt et d'un avertisseur; toutefois, dans un but d'économie d'énergie, il n'y avait pas de feux de position. Les performances ont été jugées globalement très bonnes.

Procédures de montée et de conduite

Les conducteurs, qui avaient reçu une formation spéciale, travaillaient par postes de six heures. Ils devaient stationner aux arrêts, attendre les passagers, les aider à monter et à descendre et conduire de manière sécuritaire le long de l'itinéraire prévu. Les trois jeunes hommes étaient suffisamment forts pour incliner les fauteuils roulants vers l'arrière avant de les tirer à bord le long de la rampe d'accès; mesurant entre 1,75 m (5'10") et 1,82 m (6'01"), ils n'ont éprouvé aucune difficulté concernant la visibilité, la hauteur du siège, l'emplacement des commandes manuelles et au pied, ni pour l'abaissement de la rampe et la mise en place du dispositif d'immobilisation. Toutefois, cela n'a pas été le cas pour la responsable de l'équipe qui, elle, ne mesurait que 1,60 m (5'4"); au cours d'une séance d'entraînement, elle est parvenue difficilement à atteindre les commandes au pied et à accomplir la manoeuvre prévue concernant les passagers en fauteuil roulant. Un siège réglable en hauteur serait donc la solution à ce problème. Parfois, la manoeuvre de la commande marche avant/arrière gênait le passager assis à l'avant. Les conducteurs ont trouvé les manoeuvres de direction, freinage, stationnement et marche arrière faciles à effectuer et n'ont, en général, eu aucun ennui de ce côté-là. Le soin qu'ils ont mis à faire monter et descendre les passagers handicapés a été très apprécié.

Recharge des batteries

Deux postes de recharge 25 ampères 36 volts ont été placés à l'extérieur de l'extrémité nord de la promenade Est, où étaient garés les véhicules. Bien qu'il ne soit pas recommandé de recharger à l'extérieur, pour des raisons d'humidité et de condensation, aucun autre choix n'était possible dans ce cas-ci. Afin de rendre la manipulation plus facile, ces postes ont été montés à une hauteur de travail de 1,20 m (4'). Pour effectuer la recharge,

le conducteur branchait le câble de charge à l'aide de la fiche de sécurité jaune qu'il insérait dans le véhicule, ouvrait le panneau du chargeur et réglait la minuterie, le maximum étant de 12 heures. Un voyant rouge s'allumait et un ronfleur indiquait que la charge avait commencé. La procédure était simple et aucun problème n'a été signalé, à part un incident, quand le conducteur a oublié de débrancher avant de démarrer. Un dispositif d'interverrouillage sur l'interrupteur principal empêcherait ce genre d'incident.

Entretien

Un contrat d'entretien avait été signé avec une entreprise locale mais, pour des raisons administratives, l'entretien des véhicules durant le mois de juin a été effectué par le personnel du pavillon du Canada. L'entretien était facile. L'accès aux batteries se faisait en desserrant trois agrafes en caoutchouc et en enlevant le carter. Tous les principaux organes et les accessoires ont fonctionné sans défaillance, à l'exception d'un indicateur électronique de charge qui a dû être remplacé. Les quelques réparations qui ont été faites ont montré la nécessité de rendre plus accessibles la chaîne cinématique, les freins et aussi le carter de direction, ce dernier renfermant quelques-uns des interrupteurs de commande. Il a été en outre recommandé de rendre amovibles les jupes avant et arrière, afin de faciliter les travaux d'entretien.

Confort et sécurité des passagers

Les passagers pouvaient monter et descendre à deux endroits: la station du bus maritime et l'entrée principale d'EXPO 86. Le trajet entre ces deux points prenait de quatre à six minutes, en comptant les temps de montée et de descente. Les personnes en fauteuil roulant ne manifestaient aucune crainte ni réticence,

car elles se rendaient compte au premier coup d'oeil de la facilité avec laquelle elles pouvaient monter à bord, le plancher du véhicule étant surbaissé. Cette impression de confort et de sécurité se confirmait devant le dispositif d'immobilisation et la rampe d'accès qui, une fois relevée, formait comme un garde-corps. Les usagers sont allés jusqu'à dire que ce service de navette aurait dû être prolongé à l'intérieur du site.

Quant aux personnes à mobilité réduite, elles accédaient à bord du côté opposé, par une marche de 15 cm (6") de hauteur. Ce faible emmarchement a été apprécié aussi bien par les personnes âgées que par celles qui s'appuyaient sur une canne ou des béquilles. Elles ont aussi aimé l'appui-bras qui servait également de prise durant la montée et la descente. Enfin, le plancher antidérapant a représenté un atout, surtout par temps de pluie.

Le trajet étant très court, les sièges faits en acier déployé léger n'ont pas suscité d'inconfort. Quant au toit en toile, il a été tenu pour très utile contre les intempéries.

Conclusion

Les résultats ont montré que ces véhicules permettaient de transporter les personnes à mobilité réduite en toute dignité et avec toutes les garanties de sécurité. Des perfectionnements sont certes nécessaires, mais les modifications dépendront en bonne part de l'application prévue. Enfin, on peut facilement envisager d'autres applications du véhicule, tant en version d'intérieur qu'en version d'extérieur.

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1.0 INTRODUCTION

1.1 Background

In 1983-84, a small electric carrier was designed by RUTENBERG DESIGN INC. for the Transportation Development Center (TDC) to convey mobility impaired travellers within transportation terminals. The vehicle was called SCAT 01 (small carrier for alternative transportation).

This prototype was followed by SCAT 02, a larger, more powerful model for outdoor use.

In April 1985, representatives of the Planning and Development Department of the Canada Pavilion requested that TDC provide them with electric vehicles to facilitate access for mobility impaired visitors to the Pavilion during Expo 86. Technical, user, and operational requirements were established, and the development and deployment of three motor units, two trailers, and two chargers were commissioned to RUTENBERG DESIGN INC. of Montreal.

An on-site performance study was requested by the Transportation Development Centre to evaluate the performance of the prototype vehicles and to analyze driver, passenger, and service data.

1.2 Method

Data for the evaluation was collected in three ways: daily logsheets filled out by each driver; two sets of interviews within a 5-month period with drivers, passengers, and maintenance crew; and videotape.

Because the drivers had very little time between pick-up, driving and drop-off, the logsheets were very simple in format. After each trip and at the end of the day, the driver would fill out a form, which recorded the following data:

- total number of wheelchair passengers transported per day and per hour
- total of other mobility impaired passengers transported per day and per hour
- peak time demands
- charge load per vehicle
- problems during load per shift

A sample of the logsheets is included in Appendix A.

A weekly logbook was used to verify service check-ups and to collect data regarding repairs, faults, wear and replacement of parts. A sample of the logbook is included in Appendix A.

Drivers were interviewed about the following vehicle and passenger factors:

- driver's seat position and visibility
- use of hand and foot controls
- response of vehicle to acceleration, braking, and turning
- ramp preparation for boarding
- tilting and pulling passengers up ramp
- positioning passengers in place
- use of tie-down
- platform height
- seat preparation
- storage of wheelchairs, canes and crutches
- passengers' comments

The service personnel were interviewed in regard to the following aspects of vehicle maintenance:

- access to and service of batteries and terminals
- access to and service of drivetrain and steering components
- access to and service of controls housed in front column

A cross-section of passengers were interviewed with brief questions regarding the following:

- their feeling of safety
- comfort
- vehicle speed
- the SCAT system service

Videotaped recordings were used to observe drivers, passengers, and the surrounding environment. The following elements were focussed upon:

- drivers' interaction with passengers
- traffic conditions
- drivers' attitude toward pedestrians and toward other motorists
- unforeseen problems or situations

2.0 REQUIREMENTS

Operational, technical, and user requirements were established at the beginning of this project.

2.1 System Requirements

1. To transport an estimated 25 elderly and disabled (E&D) passengers/
/peak/hr/direction from the ALRT station to the main gate.
2. To transport an estimated 40 E&D passengers/peak/hr/direction along
the West Promenade to the Canada Pavilion.
3. Each train, consisting of a motor unit and a trailer, was to
transport a total of:
 - 3 wheelchair passengers and three semi-ambulatory
 - or
 - 7 semi-ambulatory
 - or
 - any combination thereof with one driver
4. To provide room on motor unit for a stretcher.
5. To train drivers to board/deboard wheelchair users, crutch, cane,
and walker users, and to assist the elderly.
6. To provide signs for pick-up and drop-off points which do not
interfere with pedestrian or road traffic.
7. To install curb-cuts for level changes.
8. To provide key-operated vehicles and chargers.
9. To provide location for parking and charging of vehicles in area
off-limits to visitors.

10. To provide drivers with official uniforms and walky-talkies.
11. To provide one full battery charge to last each 6-hour shift without changing vehicles.

2.2 Technical Requirements

The following technical requirements were established for the vehicles:

1. Vehicles must be electrically powered and batteries rechargeable.
2. Dimensions should not exceed width 1.22 m (4'), length per unit 2.10 m (7'), height 2.40 m (8').
3. Platform step height max 0.15 m (6").
4. Ground clearance 0.075 m (3").
5. Lightweight frame construction.
6. Load per unit for 4 average adult passengers plus 45.4 kg (100 lbs.) for wheelchair, total of 364 kg (800 lbs.).
7. Brake lights on all units operated by brake pedal.
8. Front and back reflectors on all units.
9. Pneumatic tires on all units.
10. Progressive speed control.
11. Battery charge indicator with visual and audio warning.
12. Buzzer for reverse driving.
13. Horn and/or bell.

2.3 Performance Requirements

1. Hold battery charge for 6 - 8 hours of use with full load.
2. Complete charging cycle not longer than 12 hours.

3. Smooth braking with full load.
4. Smooth acceleration with full load.
5. No spinning tires on dry or wet pavement.
6. Parking brake to hold full load on 1:10 incline.
7. Stop and drive with full load on hill 1:10.
8. Top speed between 15-20 km/h.
9. Turning circle of 7 m (23') curb-to-curb with trailer.

2.4 User Requirements

The target group was identified as users of manual wheelchairs, people with canes, crutches, casts, walkers, the elderly not able to walk for long distances, and their companions. For wheelchair users, it was essential that they be moved carefully from ground level to platform vehicle level by the driver. The following requirements were established for them:

1. Ramp on each unit for wheelchair boarding.
2. Tie-down to immobilize wheelchair and to provide feeling of safety.
3. Forward riding position for wheelchair user.
4. No attachments to wheelchair which would damage chair.
5. Protection by safety gate during driving.
6. Seat for companion, side-by-side or facing.
7. Smooth acceleration, braking, and turning.
8. Protection against the elements.

For all other mobility impaired:

1. Low step to platform.
2. Highly visible edge indications.

3. Non-slippery platform surface.
4. Hand supports for balance wherever possible.
5. Armrests to facilitate getting into and out of seat.
6. Upright seats to prevent "sinking" in.
7. Room in front of seats for walking aids.
8. Storage place for aids.
9. Full standing room in front of seats.
10. Safety rope alongside vehicle at armrest level.
11. Protection against the elements.

2.5 Driver Requirements

Each driver was required to solicit the use of the SCAT 02 vehicles, to assist in boarding/deboarding, to drive the vehicle, and to charge it.

Specific requirements were:

1. To be able to tilt a passenger in a wheelchair totaling 91 kg (200 lbs), balance him/her over the axle, and pull him/her backwards up a ramp of 1:5.
2. To be aware of the idiosyncrasies of the members of the target group and know their specific requirements.
3. To be able to drive responsibly under congested traffic conditions on the sidewalk and on the road.
4. To follow the instructions for charging.

The vehicle was designed to accommodate the driver's requirements for driving the vehicle and for performing safe and efficient boarding and deboarding procedures.

These requirements were:

1. Easy access from ground level to seat.
2. Hand controls; e.g., steering, forward/reverse, horn within reach of driver's seat.
3. Foot controls; e.g., for acceleration, braking, parking within comfortable reach of right foot, with heel supported.
4. Rear-view mirror in position to observe rear traffic.
5. With seat in position, to see traffic from all sides.
6. Non-slippery surface on platform for steady position when pulling wheelchair up.
7. Room to swing wheelchair in position and back up onto seat.
8. Comfortable position to deploy ramp and tie-down.
9. Full standing room on platform.

3.0 PERFORMANCE RESULTS

3.1 Systems Operation

Of four proposed routes for transporting mobility impaired visitors to, from, and on the premises of the Canada Pavilion, two routes were selected as the ones with the highest estimated visitor frequency. One was from the waterfront station to pick up visitors and transport them to the main gate, and the other was along the West Promenade within the premises of the Canada Pavilion.

The service along the West Promenade was abandoned after the first week because of the unexpected pedestrian congestion. Service remained on Cordova Street for approximately 140 days, with a total of 10 days off for repairs, change of routes, and scheduling. Contrary to the original operational plan, the SCAT 02 vehicles did not drive on the last westerly half of the sidewalk but used the street instead, where there was much bus, car and taxi traffic.

A U-turn had to be made at the intersection of Cordova and Howe. Crossing Cordova at the intersection of Granville, the drivers were faced with heavy oncoming traffic and the traffic in and out of the public garage on Granville. A curb-cut was provided to get onto the sidewalk; the driver would then continue along in front of the train station through pedestrian traffic all the way east and then make a complete turn to go back to the main gate.

The two chargers and all vehicles not in use were kept at the north end of the East Promenade, fenced off from the public. Chargers and vehicles were locked by key. The drivers would pick-up and drop-off the vehicles at this base for recharging and overnight parking.

The first shift went from 10:00 to 16:00; the next was from 16:00 to 22:00. A total of three drivers worked on a rotation basis, including Saturday and Sunday, one driver/vehicle per shift. Vehicles would be returned to base only if vehicle charge was low, if a malfunction occurred, or at the end of the shift.

Pick-up of visitors was by demand and was encouraged by the drivers at the pick-up and drop-off points. If more than one wheelchair user would arrive, the next had to wait approximately 5 minutes. Up to three other mobility impaired visitors were transported per trip.

The efficiency of the operation could have been improved by using two vehicles and two drivers on this route; this, however, would have increased operational cost, for which there was no budget.

During the recorded time, from May 27 to August 25, 1986, a total of 11,511 mobility impaired visitors were reported to have used the SCAT vehicles on the route. Due to an immense increase in visitors within the last three weeks of EXPO 86, the use of the vehicles was stopped and all available personnel was used solely to direct visitors.

The following table shows the number of passengers reported to have been transported per day and per period:

DAILY	
Wheelchair Average	43
Mobility Impaired Average	38
Companions	101
Total Passengers/Day	182

PERIOD MAY - AUGUST

Wheelchair Total	3,723
Mobility Impaired Total	2,832
Companions Total	8,679

Total Passengers	15,234
------------------	--------

If we assume that the average/day transportation during the non-recorded period was similar to that of the recorded one, the total of mobility impaired visitors per day would be 13,365 persons.

It must be noted that the projected estimates were significantly lower than the actual number of mobility impaired visitors at the site. This fact, coupled with the lack of sufficient public information about the service, accounted for the SCAT vehicles not being used to their full potential.

3.2 Technical Performance

All motor units were equipped with a 36 V battery system, which required 12 hours charging when empty. Contrary to the typical electric vehicle set-up of a 36 V system using six 6 V batteries, SCAT 02 used three 12-volt deep cycle batteries. Since the weight/power ratio in electric vehicles is one of the most crucial aspects, this design allowed a weight saving of approximately 135 lbs. for the same power, but with a shorter battery life. Since the battery life was not a major concern for this application, this decision proved to be successful in increasing the load and driving longer with the same charge. For other applications where battery life becomes an important cost factor, the decision will certainly lean toward using six 6 V batteries.

Dimensions of all units were fulfilled according to the specifications, although it should be noted that lengthening the motor unit by about 15-20 cm (6"-8") would have facilitated the maneuvering of the wheelchair into place. All other dimensions worked well within the prescribed objectives.

The platform height of 15 cm (6") and the ground clearance of 7.5 cm (3") caused no problems for the boarding passengers or for the roads/sidewalks/curb-cuts used.

The framework of the vehicle consisted of a 2.5 x 5 cm (1" x 2") rectangular steel tube, gauge 20 with crossbraces, round tubing for the seats and posts, and steel mesh for the seats and skirts.

Weight savings could have been made by using aluminium, but the increase in manufacturing cost was not within the budget.

All frame construction proved to be well within the load requirements, including the safety factor of 2. No damage or malfunction on either of the components was reported, except for the typical wear of the skirts, e.g., dents, probably due to backing into obstructions, curb-cuts, or curbs.

Brake lights at the rear end of the vehicles had protective housings and were not damaged; bulbs in vehicle No. 3 were changed once. The brake lights were operated by a switch on the foot pedal, and this switch on vehicle No. 2 had to be readjusted. The brake lights were essential for use on the street. As an additional safety feature, each vehicle was equipped with large red reflectors at the rear and white reflectors at the front.

All vehicles were equipped with pneumatic tires, which proved to enhance riding comfort on the pavement.

Progressive speed control was achieved by a series of 4 microswitches, operated by depressing the accelerator pedal, similar to automatic transmission in a passenger car.

The battery charge indicator is an essential instrument in an electric vehicle. If it does not function well or is not heeded, substantial battery damage can occur. The electronic device used on SCAT 02 was placed on the front steering column, visible at all times to the driver. A bank of LED lights would diminish from "FULL" to "RECHARGE", and a flashing light at "RECHARGE", together with an audible buzzer, would indicate that the vehicle needed recharging. Within a 6-hour shift, there was always enough charge left to bring the vehicles back to base.

To warn pedestrians and other traffic members, a motorcycle horn was installed on the vehicles. Later, a bicycle bell was added for use on the sidewalks, since the horn was too loud.

All performance requirements were met in the design of the vehicles, with the following failures reported and repaired: replacement of diodes for the chargers, a loose bracket on the rear axle of vehicle No. 1, a loose front wheel on vehicle No. 2, a short circuit at the forward/reverse control on vehicle No. 2, and a bent ramp on vehicle No. 2.

Excellent braking was achieved with two drum brakes on the drive wheels. No brake lining change was necessary during the entire period. The parking brake held the vehicles with full load on a 1:10 incline.

A top speed of approximately 20 km/h proved to be successful on roads. On pedestrian walkways, the driver would, of course, reduce the speed. Depending on the vehicle's application, the top speed can easily be reduced to 10-12 km/h, if required, by installing the appropriate gear ratio, which is available from the manufacturer.

3.3 Driving/Boarding

The driver's position on the SCAT vehicle is at the front left side, on a seat elevated 40 cm (26") from ground level to oversee traffic. Because of space restrictions, the seat had no backrest and pivoted into a vertical position to facilitate getting into and out of the seat. On the right side were a steering wheel with a pivoting knob, the controls for forward/reverse, the key switch, and the battery charge indicator. Mounted on the left front canopy post, which served as an additional hand support while driving, were a rearview mirror and a horn. With his right foot, the driver controlled the accelerator pedal, brake pedal, and parking brake.

Interviews and observations revealed that steering with one hand was extremely smooth at all speeds. All three drivers, measuring between 178 cm (5'10") and 185 cm (6'1"), had no difficulty reaching and operating all hand and foot controls. A female supervisor, measuring 163 cm (5'4"), had difficulty reaching the foot controls. In the future, an adjustable seat would be necessary.

The forward/reverse control lever mounted on the right hand side of the steering housing was easy to operate but lacked defined demarcations of position. It also sometimes interfered with the front passengers' arm. The control should be located on the inside of the housing, although in the vehicle's present design it would have interfered with the driver's knee.

Much attention was required by the drivers to cope with the road traffic along Cordova Street and the congested pedestrian traffic on the sidewalk in front of the train station. Since the vehicles were originally designed for road traffic and therefore not equipped with running lights and turn signals,

drivers had to give directional signals by hand. The bright vehicle colours, red and white, and the yellow driver uniform helped to distinguish both vehicle and driver from the rest of the traffic. In general, all traffic members behaved reasonably well and no accidents occurred on the roads or sidewalks. All drivers were given a driving course, together with a manual prepared by RUTENBERG DESIGN INC., to familiarize them with the vehicles' characteristics and the idiosyncrasies of the mobility impaired population. Drivers also underwent a hands-on training course for boarding/deboarding wheelchairs.

For boarding/deboarding a wheelchair, a ramp was lowered from the left hand side of each SCAT 02 vehicle. In its upright position, the ramp served as a safety gate while driving. All three drivers were physically capable of boarding/deboarding the wheelchair into its designated place, two platform areas should be extended: (1) behind the wheelchair, (2) between the wheelchair and the driver's seat.

The tie-down, which consisted of a hook, a rope, and a cleat, was performed by the driver in a squatting position. Raising the ramp to its vertical position was achieved by lifting it with one foot or bending the knees and reaching for it with one hand.

The seat bench was divided into three sections - two seats and one middle panel. A wheelchair would take up one seat and the middle panel, leaving one seat for another passenger, usually a companion. In the case of a crutch or cane user, the middle section was folded up and the space used for storage of the walking aid.

Boarding and deboarding at the train station was executed on the sidewalk, requiring the implementation of the ramp. At the main gate, SCAT was

parked on the right hand curb, and a wheelchair could be rolled directly from the curb onto the SCAT platform and vice versa, which saved time and effort, especially during peak hours.

Little assistance was necessary for other mobility impaired visitors, apart from telling them not to board over the ramp. Most impaired visitors arrived with a companion(s) who appreciated the opportunity to accompany them on the vehicle. To make the platform edge more visible to visitors with sight impairments, bright yellow dots were placed on the dark floormat.

3.4 Charging

To start charging, the vehicle was backed against the charger wall and the key turned off. The driver would connect the yellow plug to the vehicle and open the charger panel with a key. He then would set a manual timer to 12 hours. At that point, two visual and one audio signal would indicate that charging was in progress. A red light would go on and then the ampmeter needle would move, combined with an audible hum from the charger. If one of these indicators failed, maintenance was to be contacted. The panel would then be locked. This operation failed only once, when a faulty diode was found and replaced. Bilingual operating instructions were printed inside the charger panel. The drivers reported no difficulties in performing this procedure, which took between 20-40 seconds.

After the vehicle had been charged overnight, the driver would pick it up the next morning. He would pull the bright yellow plug from the vehicles' receptacle, with a force of approximately 0.9 kg (2 lbs.), and had enough clearance to work comfortably. This yellow plug would be inserted into the

charger for storage at a comfortable working height of 1.20 m (4'). The plug had a safety device that slid in and out like a shield which would prevent anyone coming into contact with the terminals. The driver would check the battery charge indicator on the front panel of his vehicle and when it read "FULL", he would drive off.

3.5 Maintenance/Service

A logbook was provided for a local service contractor who performed preventive maintenance. Spare parts, such as one full seat assembly, tires, switches, wireharness, and skirts, were stored at the parking base.

Maintenance included checking the water level in the batteries, tire pressure, brakes, steering tolerances, electrical contacts, and transmission oil. After an initial four-week check-up, the service was taken over by the Pavilion's Exhibition Maintenance crew to facilitate administration. During the complete period, the following repairs were done:

1. Replacement of wheel nuts on one front wheel.
2. Installation of an additional bracket for rear axle on all vehicles.
3. Replacement of one electronic battery charge indicator.
4. Replacement of wireharness in one vehicle after a short circuit.
5. Replacement of flexible wires on forward/reverse control.
6. Welding of one bent ramp.
7. Replacement of one diode on each charger.
8. Replacement of one set of brake bulbs on one vehicle.

The replacements were due either to faulty components, wear or, in the case of the forward/reverse control, the design.

To lift the front or rear end for access to the components, a wooden

frame was provided by the contractor.

All repairs which required getting to the wheels, the drivetrain, or the steering linkage proved to be time consuming because the skirts could not be removed easily. The same was true for the steering housing. The skirts and the housing must come off more easily for longer operating periods because more frequent access to brake linings and steering linkage will be necessary.

Access to the batteries was no problem and required simply releasing 3 rubber snaps to remove the complete housing.

All other parts and components were found to be very reliable.

3.6 Passenger Safety and Comfort

Visitors were boarded and debarked at the train station exit and at the main gate. A typical ride took 4 - 6 minutes, including boarding and debarking, which took about 30 - 40 seconds each.

It was observed that about 90 % of the wheelchair visitors arrived with a companion. The same applied for the other mobility impaired, some often accompanied by 2 - 3 people. If there was an extra seat available, the companion was usually transported at the same time. Drivers made sure that groups were not split up and that visitors did not mind waiting a few minutes for the next ride. Five minutes was acceptable, ten minutes was not. During peak times, a second vehicle could have been used, but driver scheduling and cost posed a problem. Passenger data was obtained from three sources; observations by drivers, two interviews conducted over the 5-month period, and contractors' observations.

Interviews were very short. as passengers did not want to spend too much time answering questions after they had debarked. Nevertheless, many did

answer questions regarding their feelings of safety, comfort, and service operation.

Not one negative comment by passengers was reported during the entire period. People were enthusiastic when transported but confused because there were no signs for this service. The thought expressed most often was, "Why aren't there more of these vehicles on the fairground?"

Wheelchair visitors felt very secure with the application of a tie-down and the ramp pulled up on their side. Other mobility impaired passengers welcomed the low step, the armrest on the seats, the centre panel for storing their aids, and the availability of extra hand supports on the vehicle such as posts, seat backs, and armrests. No objections were made about the steel mesh seats, probably because similar designs were found throughout the fair and because the ride lasted only a few minutes.

The rippled floor mat provided a safe standing surface even when wet. The sailcloth canopy was welcomed as an effective protection against the elements. If rain had persisted, an additional roll-down protection in the rear would have been beneficial.

4.0 CONCLUSION

The results of the evaluation proved that the SCAT vehicles were a sound technical and human approach to transporting mobility impaired people under the given conditions.

The SCAT operation was beneficial for these visitors and would have been even more effective if two vehicles could have been used on the same route. Additional SCAT routes on the EXPO grounds were suggested by many visitors.

Providing signs indicating pick-up and drop-off points and advertising this service over the general information channels would have increased the number of target users. The number of transported visitors indicated clearly a substantial need for such an operation. The use of SCAT also showed that at an event where visitor numbers can fluctuate greatly by day and hour, alternatives should be considered and be built into the operational plan.

Technically, the vehicles performed successfully, except for some repairs and replacements usually associated with prototypes.

Room for improvement exists in many areas, but many of the changes will depend on the specific application of these vehicles. Some of the factors to be considered depending on the nature of operation and function are battery life, cost, weight, charging, operating cycle, and passenger characteristics.

Further application of SCAT O2 design can easily be seen under similar conditions outdoors in parks and fairgrounds, and indoors for large exhibitions such as trade shows or museums.

5.0 RECOMMENDATIONS

For future application of SCAT vehicles, the following recommendations must be considered:

- Ascertain a relatively accurate estimate of potential users.
- Make the target group fully aware of the availability of the service through signs, advertisements, etc.
- Provide complete hands-on training for the drivers.
- Make the driver's seat adjustable.
- Ensure that vehicle speed is appropriate to the environment.
- Store the charger indoors.

- Install a safety switch to prevent a driver driving off while the vehicle is being charged.
- Make the skirts easy to remove for service and maintenance.

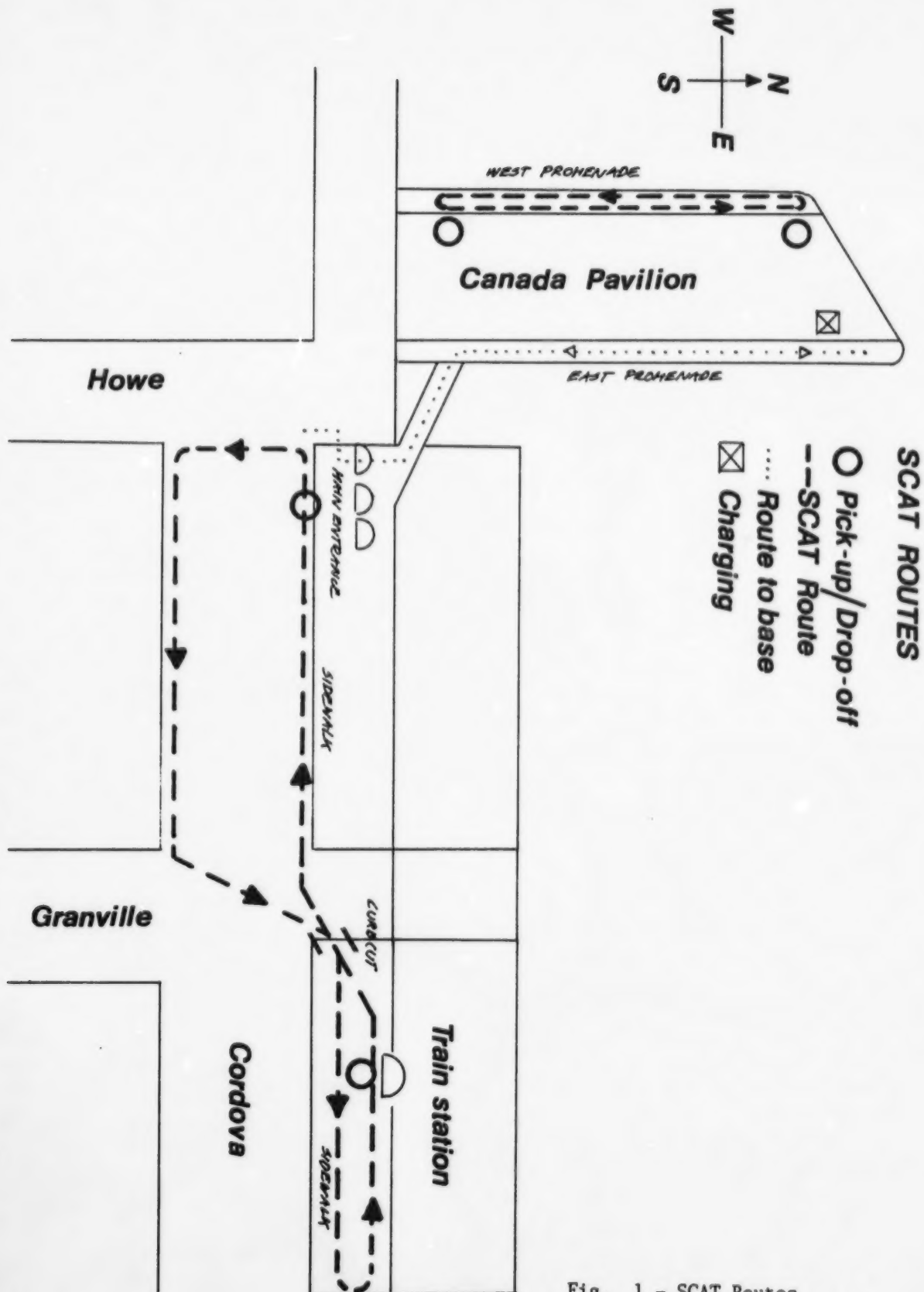


Fig. 1 - SCAT Routes



Fig. 2 - Boarding Wheelchair Visitor



Fig. 3 - Positioning on Platform

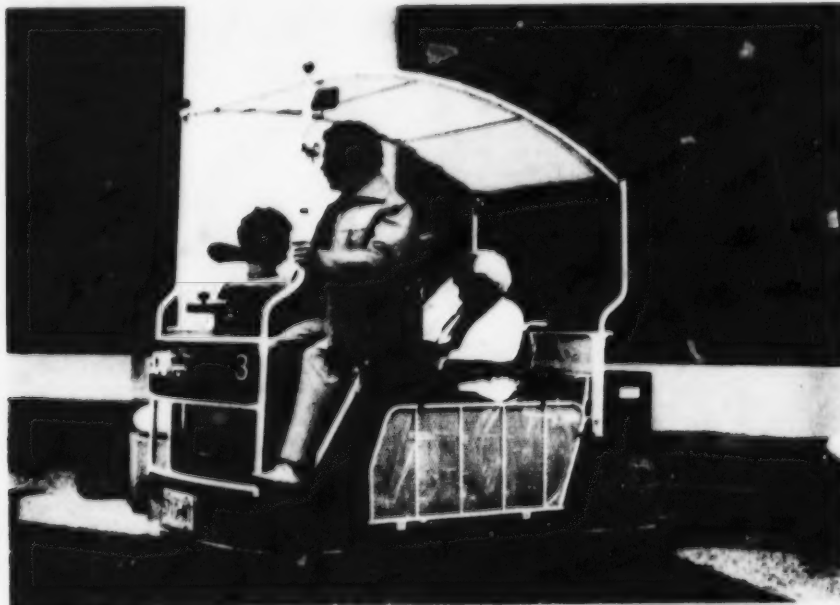


Fig. 4 - Motor Unit Loaded with Wheelchair & Companion

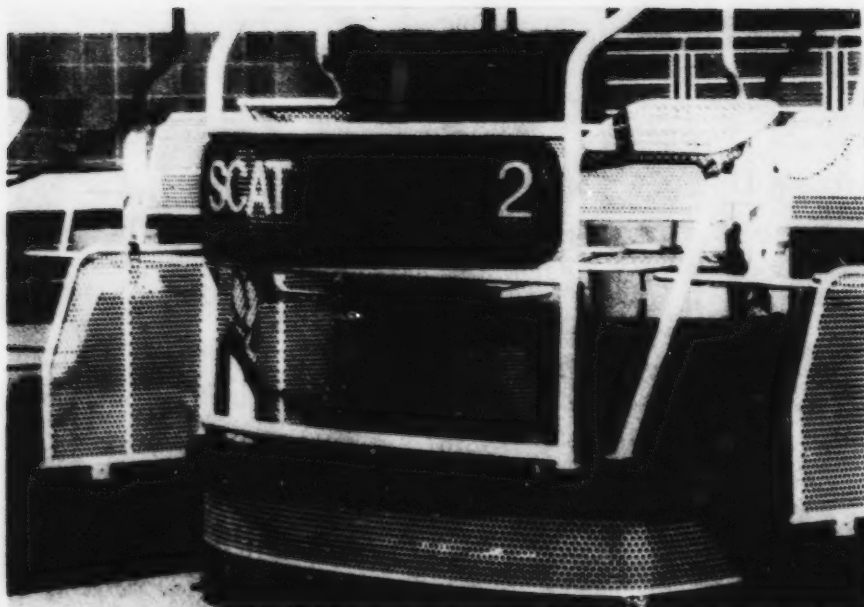


Fig. 5 - Drivers Seat, Steering Wheel & Foot Controls.

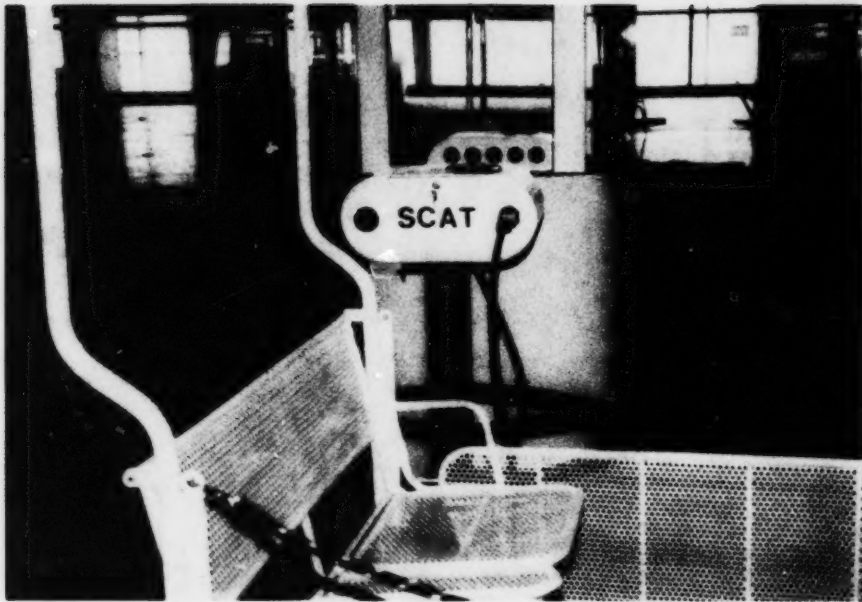


Fig. 6 - Charger with Locked Panel

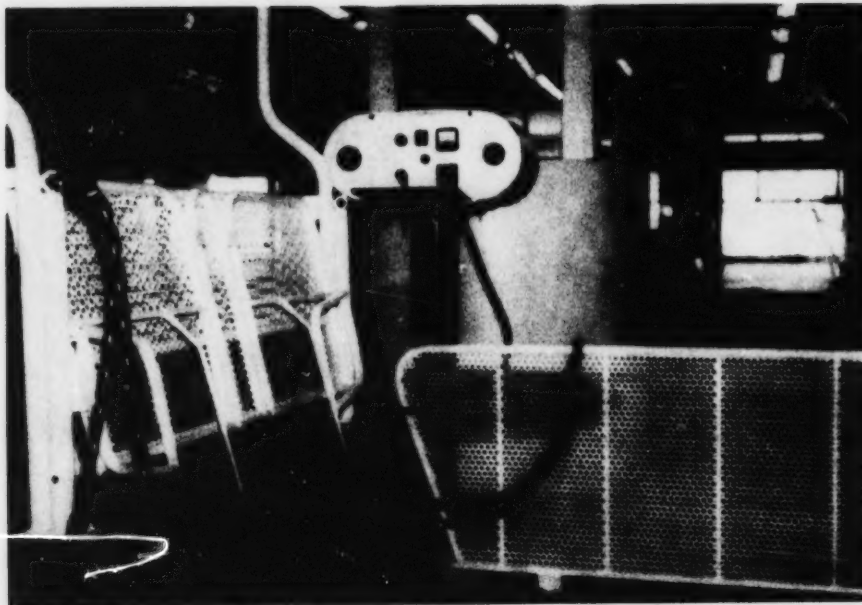


Fig. 7 - Charging in Progress

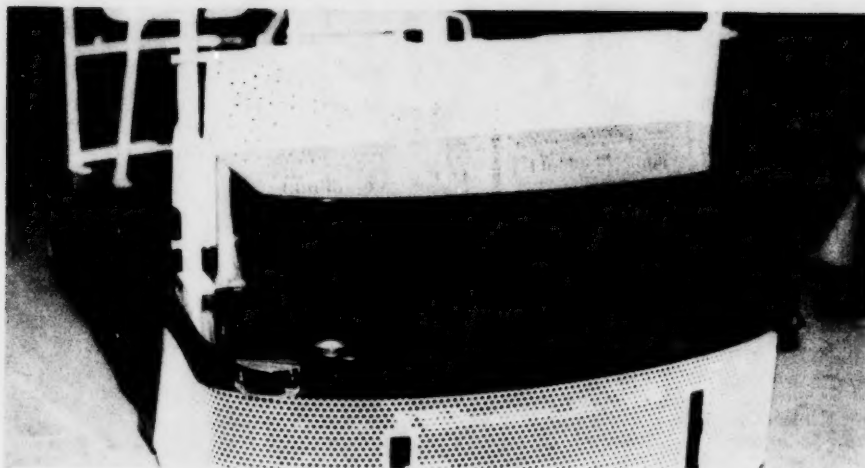


Fig. 8 - Battery Housing

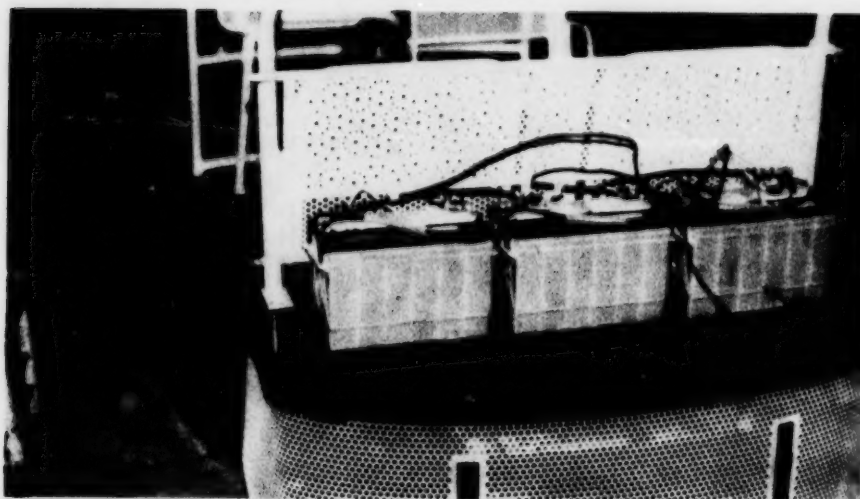


Fig. 9 - Battery Housing Removed for Access to Batteries

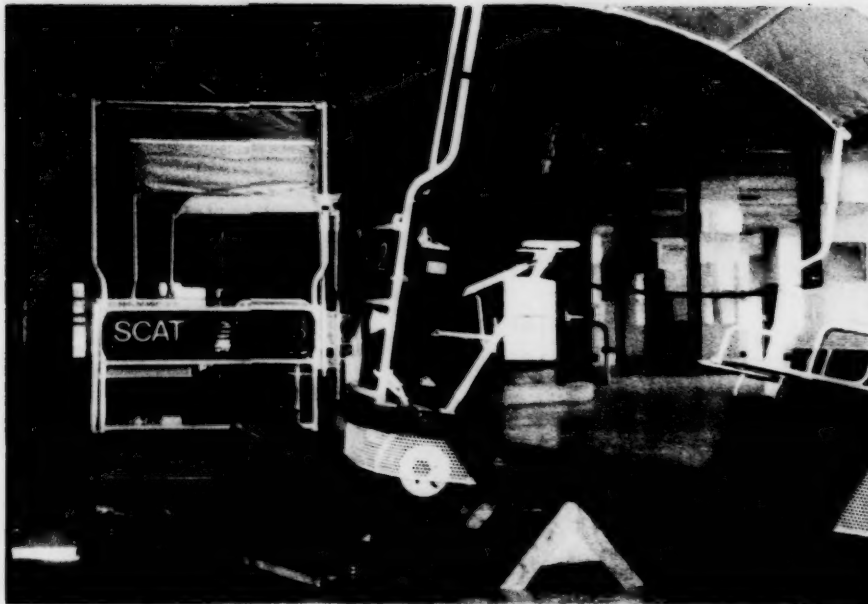


Fig. 10 - Support Frame Supplied by Contractor for Access to Front and Rear End of Vehicle

APPENDIX "A"

LOGSHEETS, DRIVERS & SERVICE

DATE: _____

DRIVER: _____

HOURS	WHEELCHAIRS	ELDERLY	MOBILITY IMPAIRED ESCORTED	FAMILY MEMBERS ATTENDING	BATTERY CHARGE
0900					
1000					
1100					
1200					
1300					
1400					
1500					
1600					
1700					
1800					
1900					
2000					
2100					
2200					

PERIODIC MAINTENANCE SCAT

MONTHLY	DATE	(veh.)					DATE	(veh.)				
		1	2	3	4	5		1	2	3	4	5
1. Check brakes and brake light operation.												
2. Check steering, linkage and adjust if necessary. Lubricate moving parts.												
3. Check electrical contacts and components.												
4. Check tire pressure.												
5. Check charger station.												
6. Grease front wheel bearing of motor unit.												
7. Grease castor bearing and wheel-spindles (trailers only).												
8. Check oil level in differential.												
9. Check battery (Curtis) indicator gage.												
10. Check water in batteries, weekly and monthly. Fill after charging.												
In addition to the above points a general visual check for loose nuts, wear and tear of motor unit and trailer should be made.												
Initial for service company												
Initial for CHPC												

COMMENTS:

APPENDIX "B"

DRIVERS OPERATION MANUAL

RUTENBERG DESIGN INC.

UWE RUTENBERG, MICHAEL G. BARBER

480, BOUL. STRATHMORE, DORVAL, QUE. H9S 2J4
TEL. (514) 636-4089

DRIVER OPERATION MANUAL FOR SCAT

- A. Typical Passenger characteristics.**
- B. Driving, handling and charging.**
- C. Boarding and debarking of passenger.**
- D. Trouble shooting.**

Introduction

SCAT was designed by RUTENBERG DESIGN INC. for the Transportation Development Centre of Transport Canada. A number of these vehicles are now in operation for the Canada Pavilion to assist mobility impaired visitors in getting from the waterfront station and the main gate to the end of the west promenade.

SCAT is an electrically powered vehicle which can pull one trailer. The vehicle was developed specifically for the transportation of mobility impaired visitors, with the objective being SAFETY, NOT SPEED.

In order to achieve this objective, the driver is as important as the vehicle. Following strictly the instructions provided should give passengers a smooth and trouble free service; one which will be remembered long after EXPO 86 is over.

General

1. Keep vehicle clean
2. Keep FLOOR MATS DRY to prevent slipping
3. DO NOT HOSE DOWN MOTOR VEHICLE

A. Typical Passenger Characteristics

WHEELCHAIR VISTOR: Cannot walk, but can hear, see and feel. Has often great strength in upper body. Others are accompanied by friend/relative who pushes wheelchair. Wheelchair vistor considers wheelchair as his/her "legs". Avoid banging footrest against other equipment. Avoid shoulder clapping or talking loudly.

COURTESY NOT PIT Y is the key.

**VISTORS WITH CRUTCHES
CANES, AND WALKERS :**

Cannot walk or move fast, only little steps. Require
STABLE HAND SUPPORT e.g. vehicle posts, armrest, driver
seat. DO NOT BOARD these vistors over RAMP. If assistance
under forearm is required, ask first, DO NOT GRAB arm.
PATIENCE is advised. Their PACE might be slower.
STORAGE of AIDS between seats.

ELDERLY VISITOR:

Can have reduced stamina, vision and/or hearing.
Require LOW STEP, HAND SUPPORTS. Make them AWARE of
step edge. Some cannot slide backward. Assist gently
by supporting their forearm if required.

WARNING: Failure to comply with the following instructions may result in personal
injury or property damage.

B. Driving, handling, charging

1. Read operation manual first, before starting to drive.
2. When familiar with all controls, drive vehicle UNLOADED to get used to
acceleration, decelleration, braking, turning and parking.
3. Practise charging procedure.
4. Practise boarding and debording wheelchair with colleague first, before
boarding actual wheelchair user.
5. Avoid sudden starts and stops.
6. Do not operate on public roads.
7. Use ramps for level changes.
8. DO NOT drive over obstacles higher than 1".
9. Study controls and be familiar with their function before operating vehicle.
10. AUTHORIZED PERSONS ONLY to operate vehicle.

11. Operate vehicle from driver seat only.
12. Remain seated in moving vehicle.
13. Only ONE DRIVER on driver's seat.
14. Keep arms, legs and feet inside vehicle.
15. Drive slowly on turns.
16. DO NOT make turns on hills or inclines.
17. DO NOT hold vehicle on hill or incline by accelerator pedal, apply brakes.
18. Set "PARK" brake, before leaving vehicle even on a "level" surface.
19. Remove key when vehicle is unattended.
20. DO NOT sit on steering wheel.
21. DO NOT FORCE STEERING WHEEL, when vehicle is not moving.

BEFORE STARTING TO DRIVE

1. YELLOW Battery charger plug must be disconnected and indicator must show "full".
2. DO NOT DRIVE vehicle when indicator shows EMPTY.
3. ALL RAMPS must be secured in UPRIGHT position.
4. Secure TRAILER LINKAGE, CHECK all TIRES.
5. Secure ELECTRICAL TRAILER CONNECTION.
6. Secure all GUARD ROPES on sides of vehicle.

TO START

1. Get into driver's seat.
2. TURN KEYSWITCH "ON".
3. Turn "F & R " switch to FORWARD or REVERSE gently
4. Release "PARK" brake.
5. Accelerate slowly by depressing pedal.
6. DO NOT CHANGE FORWARD AND REVERSE, while vehicle is moving. Always bring vehicle to a full stop, before changing direction.

7. DO NOT drive in REVERSE with trailer
8. DO NOT USE SKIRTS for lifting and pushing vehicle.

TO DRIVE

1. Use brakes to slow down vehicle or to stop.
2. Use horn only for warning situations.
3. Make sure passageway is free and clear for turning space.
4. Approach ramps perpendicular, UP and DOWN.
5. DO NOT DISCONNECT TRAILER when loaded.
6. DO NOT RACE the vehicle even when unloaded.

TO CHARGE

1. RETURN vehicle to CHARGER STATION
 - Each evening
 - When INDICATOR shows flashing RESERVE WARNING.
2. Park vehicle close to charger station ring with motor unit rear seat closest to station.
3. CHARGER RECEPTACLE is underneath rear seat of motor unit.
4. APPLY "PARK" brake to vehicle.
5. TURN "OFF" keyswitch and REMOVE KEY.
6. UNLOCK CHARGER DOOR.
7. turn CHARGER switch to "OFF".
8. Connect YELLOW PLUG to vehicle receptacle.
9. Turn CHARGER switch to "ON" position in clockwise direction. RED LIGHT will go on, ammeter needle will move.
10. Vehicle should be charged until indicator shows FULL.
11. When vehicle is fully charged TURN "OFF" CHARGER switch.

12. Disconnect YELLOW CHARGER PLUG.
13. Secure YELLOW CHARGER PLUG into receptacle at charger station.
14. Lock CHARGER STATION.
15. DO NOT DISCONNECT PLUG, while charger switch is "ON".
16. DO NOT switch "ON" keyswitch on vehicle while charger is connected.

REPORT ANY DAMAGE OR FAILURE IMMEDIATELY AFTER SECURING VEHICLE AND REMOVING KEY.

C. Boarding and Deboarding of Passengers

Potential passengers are: Visitors with manual wheelchairs
Visitors with crutches
Visitors with walkers, canes
Elderly visitors with walking difficulties
Elderly visitors with reduced stamina
Pregnant women

DO NOT BOARD: Children , teenagers or any other visitor able to WALK without difficulties.

Wheelchair Users

1. When boarding passenger, apply "PARK" brake and switch key "OFF". ALLOW SPACE for boarding on side of vehicle.
2. Access for manual wheelchair user is on the left hand side where the ramps are located.
3. Approximately 4' (1.20 m) are needed in front of ramp when in lowered position.
4. Lower ramp to ground.
5. Fold both seats back. Swing armrest against seat frame.
6. Approach wheelchair passenger with back to ramp, step up to platform and wheel the chair against ramp lip. STOP.

7. After telling passenger of your intention, TIP passenger slowly back until his/her weight is over wheelchair axle.
8. Pull wheelchair up ramp and swing back against seat frame.
9. SECURE wheelchair by applying his/her HANDBRAKE and by placing HOOK on cross frame under seat of wheelchair and pull cord to fasten.
10. SECURE RAMP in vertical position.
11. For deboarding, bring wheelchair down ramp BACK FIRST, slowly descending ramp.
12. DO NOT board ELECTRIC WHEELCHAIRS.
13. DO NOT PUSH WHEELCHAIR up ramp front first.
14. DO NOT BOARD TWO WHEELCHAIRS ON MOTOR UNIT.

Other Mobility Impaired

1. Make sure SEAT FRAME rests into HOOK of ARMREST.
2. Assist by pointing out LOW STEP, CANOPY POST, ARMREST, SEAT FRAME for additional SUPPORT.
3. BOARD these visitors on RIGHT HAND SIDE of vehicle.
4. PASSENGER CAPACITY: 2 adults per bench. For each adult 2 children of up to 6 years can be substituted.
5. Users of crutches and canes can use driver's rear support to ease getting in and out of seat. They can store their aids, resting on floormat, between the seats with centre seat in vertical position.
6. Hand baggage can be stored under seat BUT MUST BE SECURE.
7. Before starting to drive make sure all SAFETY ropes along the sides are in place.
8. CHECK when passengers are leaving that nothing has been left behind.
9. DO NOT ALLOW passengers to STAND on platform while vehicle is moving.

D. Trouble Shooting

1. If vehicle does not move after turning keyswitch "ON" and depressing accelerator pedal.
 - Check if F & R switch is in FORWARD or REVERSE.
 - Check if battery indicator shows sufficient charge.
 - Check if front wheels are not up against obstacle.
2. If vehicle still does not move, switch keyswitch "OFF", remove key, apply "PARK" brake and inform SUPERVISOR.

WARNING: DO NOT OPEN BATTERY BOX or TAMPER WITH ELECTRICAL COMPONENTS.

Name of supervisor: _____

Tel. No. : _____

APPENDIX "C"
MAINTENANCE AND PARTS MANUAL

RUTENBERG DESIGN INC.

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Maintenance and Parts Manual

SCAT 02

March 1986

This Maintenance and Parts Manual is intended to acquaint the service person with specific procedures for service and maintenance of the SCAT 02 electric vehicle and trailer. The main mechanical and electrical components used in this vehicle are illustrated and specified for ease of maintenance and parts replacement.

It is assumed that only a person who has knowledge of servicing electric vehicles similar to golf cars will be responsible for servicing and for repairs. Since SCAT 02 is a customized electric vehicle and not yet in full production, attention has been drawn only to the main aspects of the vehicle that are important for servicing.

Should any difficulties arise during the servicing and maintenance routine, that are not covered by this manual, please call collect:

RUTENBERG DESIGN INC.

(514) 636-4089

Listed below are a number of normal maintenance requirements for the SCAT 02 vehicle. They should always be performed by a qualified service person appointed by RUTENBERG DESIGN INC.

1. Maintain proper water level in batteries.
2. Keep all battery wire connectors and posts free of corrosion and connectors tight.
3. Maintain correct air pressure in all tires.
4. Lubricate (motor unit) front wheel bearings, and (trailer unit) castor pivot bearings and wheel spindles.
5. Adjust the service and park brake as well as the accelerator pedal as required.
6. Check front wheel alignment for proper toe-in ($3/8$ " to $1/8$ ").

Tire Care

Check the tires for cuts, punctures and proper inflation. We recommend the following tire pressure.

Motor unit	front - 40 psi
	rear - 60 psi
Trailer unit:	front - 30 psi
	rear - 30 psi

Lower tire pressure may damage the tire and increase the current drain on the batteries. Be sure to check to see if wheel nuts are in place and properly tightened.

Lubrication

Listed are the main check points, type lubrication, and the time intervals for lubrication changes.

1. Drive Unit

Drive units are filled with 10 oz. of SAE 90 weight EP hypoid gear lubricant. This amount fills the drive unit to a level just below the plug in the left side of the drive unit. Check oil level monthly and change the oil once per season.

2. Front wheel bearings (Motor Unit)

Outside bearings should be checked monthly so that bearing surface is always greased. Ensure that plastic dirt seal is always replaced over wheelhub after maintenance.

3. Castor bearings (Trailer Unit)

Grease castor bearings and all wheel spindles monthly.

4. Steering box

The steering gear box lubricant level should be checked yearly and filled to overflowing through filler plug. Ninety weight gear lube should be used for any additional lubrication.

5. Linkage

Standard machine oil or WD - 40 lubricant applied to all moving parts and nylon bushings will ensure smooth, quiet operation and the prevention of rust. Monthly lubrication recommended.

6. Battery terminals

Thoroughly clean battery terminals, posts and battery fixing parts to prevent build-up of acid corrosion.

Periodic Maintenance List

monthly:

- Check brake operation, brake lights and accelerator linkage. Adjust if necessary.

- Check steering, linkages and adjust if necessary. Lubricate moving parts.
- Check electrical contacts and components.
- Check tire pressure.
- Check charger station.
- Grease front wheel bearings (motor unit) and castor pivot bearing, and wheel spindles (trailer unit).
- Check oil level in differential.
- Check battery (Curtis) indicator gage.
- Fill in service sheets. *

*Service sheets can be found at the back of this manual.

Charger Station

(Lester Components)

CHARGING INSTRUCTIONS

1. SET FOOT PARK BRAKE ON VEHICLE.
2. TURN VEHICLE KEYSWITCH OFF.
3. TURN CHARGER SWITCH OFF.
4. CONNECT YELLOW PLUG TO VEHICLE.
5. TURN CHARGER SWITCH ON A FULL TURN LEFT.
6. CHARGE OVERNIGHT WHEN LOW.

CHECK

7. CHECK THAT RED CHARGER LIGHT IS ON WHEN CHARGING.
8. CHECK THAT AMMETER NEEDLE IS MOVING.

DO NOT

DO NOT DISCONNECT YELLOW PLUG WHEN RED LIGHT IS ON.
DO NOT OPEN CHARGER HOUSING OR TAMPER WITH ELECTRICAL COMPONENTS.

WARNING

THIS CHARGER IS FOR USE ONLY ON SCAT 36 VOLT BATTERY SYSTEM.
TO DISREGARD CHARGING INSTRUCTIONS WILL RESULT IN SERIOUS DAMAGE TO CHARGER AND/OR BATTERIES.

INSTRUCTIONS POUR RECHARGER

1. METTRE LE FREIN À PIED DU VÉHICULE.
2. FERMER LA CLEF DU PERMUTATEUR DU VÉHICULE.
3. FERMER L'INTERRUPTEUR DU CHARGEUR.
4. BRANCHER LA PRISE JAUNE AU VÉHICULE.
5. ALLUMER L'INTERRUPTEUR DU CHARGEUR
6. RECHARGER PENDANT LA NUIT LORSQUE LES PILES SONT BASSES.

ASSUREZ-VOUS

7. ASSUREZ-VOUS QUE LA LUMIÈRE ROUGE DU CHARGEUR SOIT ALLUMÉE PENDANT QUE VOUS RECHARGEZ.
8. ASSUREZ-VOUS QUE L'AIGUILLE DE L'AMPÈREMETRE ROUGE.

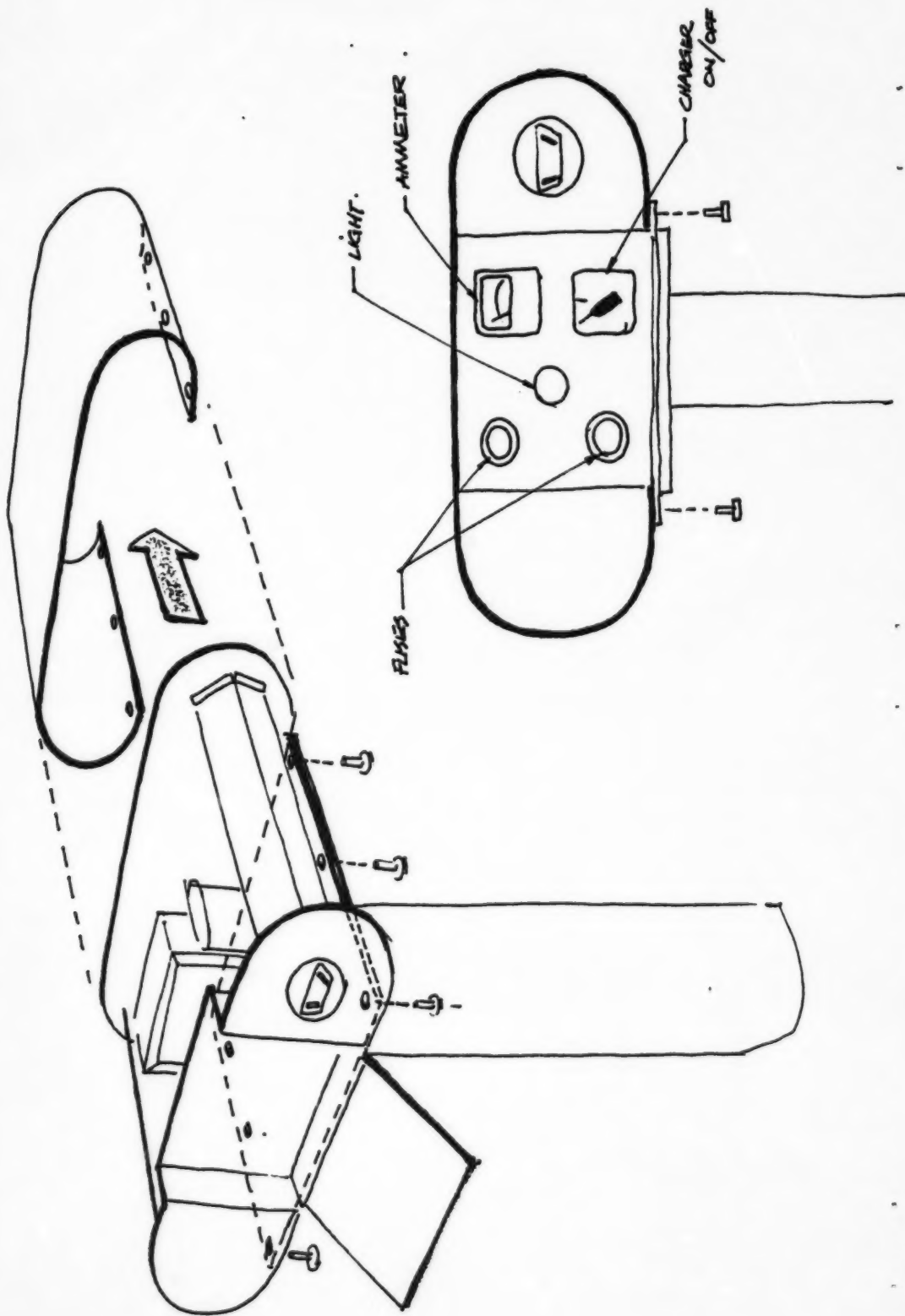
NE PAS

NE PAS DÉBRANCHER LA PRISE JAUNE QUAND LA LUMIÈRE ROUGE DU CHARGEUR EST ALLUMÉE.
NE PAS OUVRIR LE BOÎTIER DU CHARGEUR ET NE PAS JOUER AVEC LE FILAGE ÉLECTRIQUE.

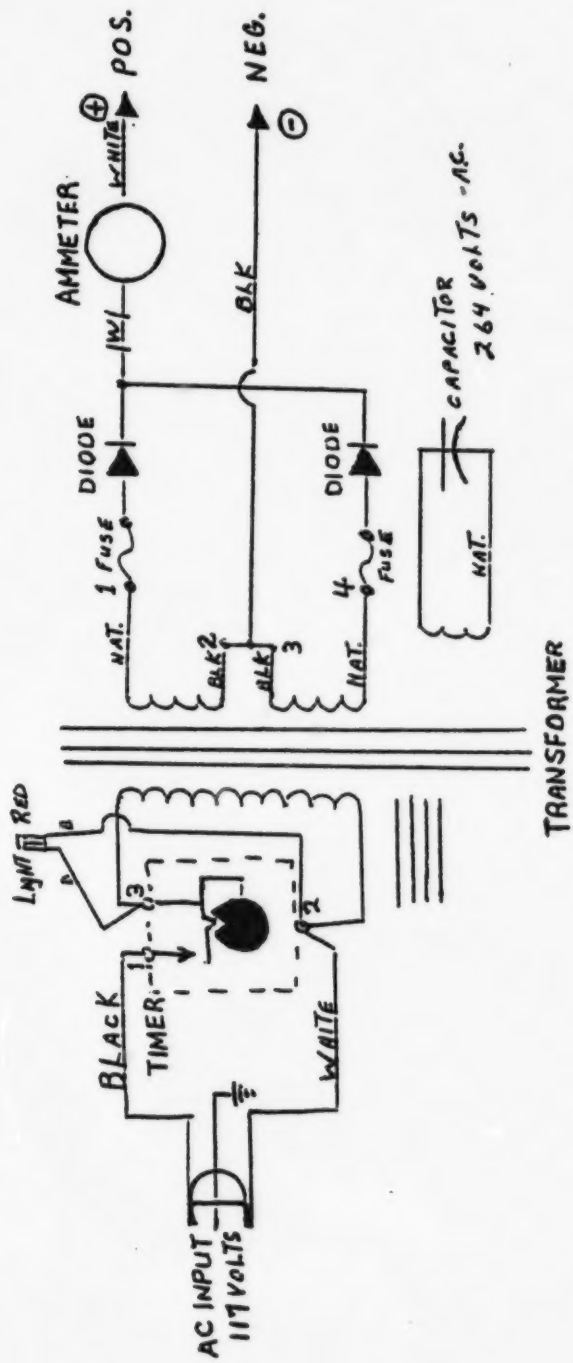
ATTENTION

CE CHARGEUR DE 36 V EST EXCLUSIVEMENT UTILISÉ POUR LE SYSTÈME DU VÉHICULE SCAT.
SI LES INSTRUCTIONS NE SONT PAS RESPECTÉES DE GRAVES DOMMAGES AU CHARGEUR ET AUX PILES EN RÉSULTERONT.

- ① REMOVE 6 SCREWS (BELOW COVER).
- ② PULL COVER TOWARDS BACK.



WIRING DIAGRAM LESTER 8600 CHARGING STATION



Parts:

Electrical

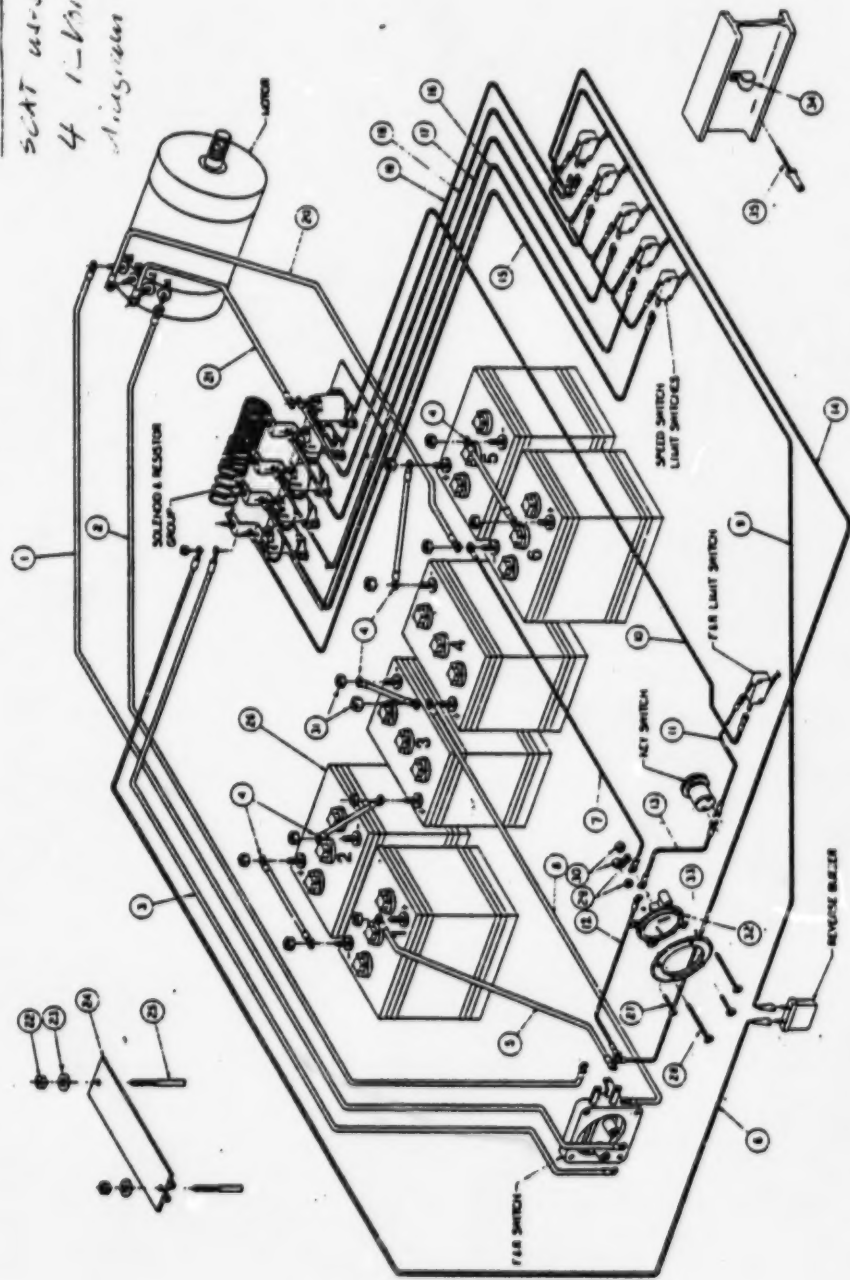
(Club Car Components)

COOPERATION

SCAT uses

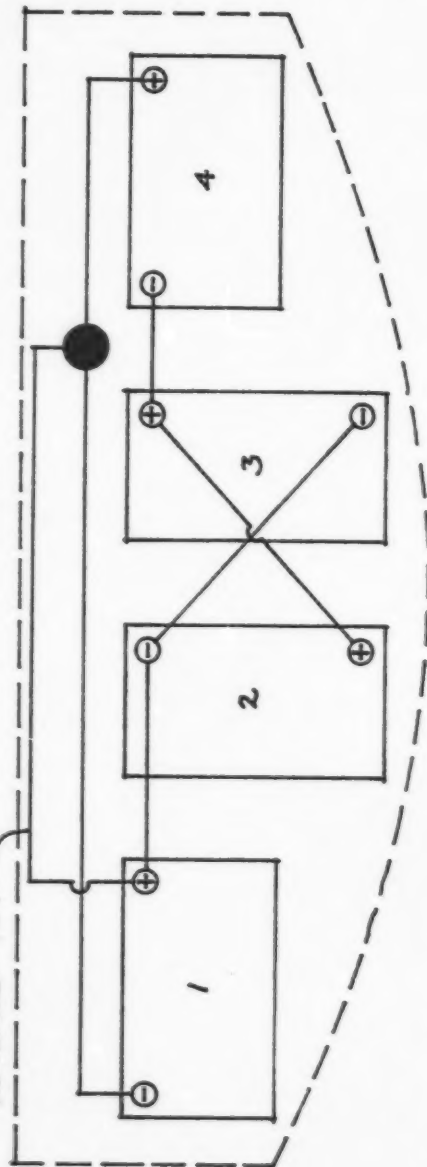
4 1-1/2" boxes

Diagram next page



INCLUDE PART NUMBER OF EACH PART ORDERED AND SERIAL NUMBER OF CAR

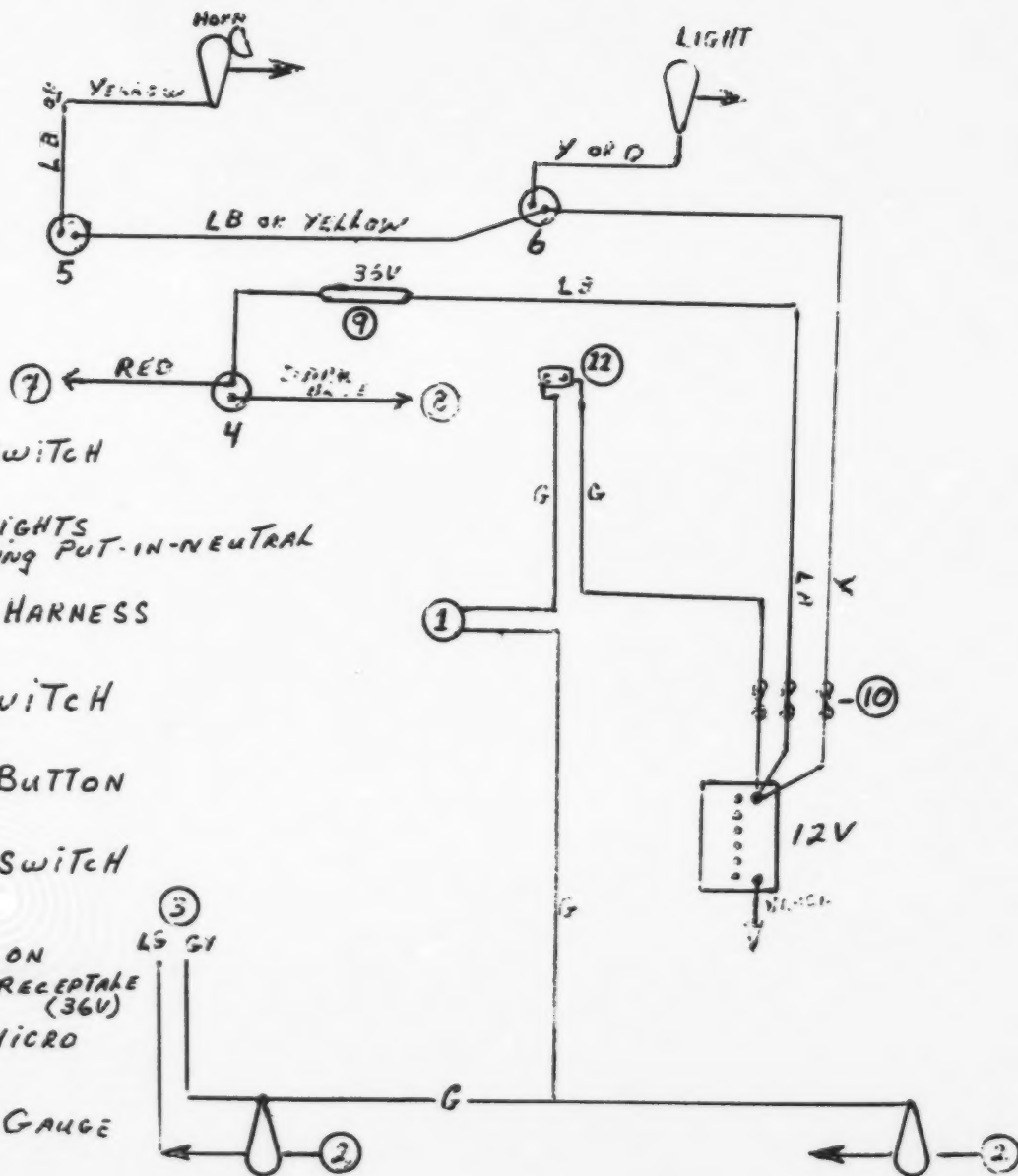
LEFT
RIGHT



BATTERIES - 12 VOLT DEEP CYCLE
450 CRANKING AMPS

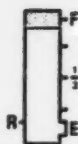
MOTOR UNIT
BATTERY CONNECTIONS

WIRING DIAGRAM FOR LIGHTS, SWITCHES,
GAGES AND HORN FOR MOTOR & TRAILER



- ① BRAKE SWITCH
- ② BRAKE LIGHTS
*FOR PARKING PUT-IN-NEUTRAL
- ③ TRAILER HARNESS
- ④ KEY SWITCH
- ⑤ HORN BUTTON
- ⑥ LIGHT SWITCH
- ⑦ TO WHITE ON
CHARGER RECEPTACLE
(36V)
- ⑧ TO F+R MICRO
- ⑨ POWER GAUGE
- ⑩ FUSES
- ⑪ BRAKE MICRO

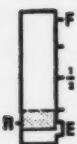
READING THE GAGE



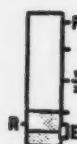
BATTERIES FULLY CHARGED



BATTERIES BEING DISCHARGED.
Lights move down one at a time.



RESERVE WARNING.
Flashing light.
Charge needed soon.



EMPTY ALARM
~~Intermittent~~ flashing lights.
Return for charge now.



RESET
After proper charging time.

Only after the batteries are about 80% recharged, the CURTIS resets to the Full position - the "Empty" alarm goes off, the top light comes on. Note that the gage does not step back up the light array, but resets to Full all at once. Note also that from the moment of reset another 2-3 hours of charge is required to fully charge the batteries.

The CURTIS is designed for permanent installation on your golf car. The display remains lit all the time. Its energy use is miniscule and in no way will drain your batteries. However, for extended periods of disuse, it is advisable to disconnect the gage. If for any reason you disconnect the CURTIS, use your golf car and then reconnect the CURTIS, the unit may be out of step with the batteries until you have fully charged them again.

Once installation of the CURTIS has been completed and the unit is functioning correctly, there are two ways your CURTIS will indicate that you are having a battery, charger or golf car electrical problem.

- 1) The CURTIS will not reset to Full during the charging process.
- 2) The CURTIS display runs down in a very short time.

NO RESET

If the batteries have been on charge for the required time and the gage has not reset, check your charger and then your batteries as described below.

First check to see that the charger-to-wall plug and the charger-to-vehicle plug did not become unplugged.

Check your charger by turning it on and seeing that the ammeter indicates current flow. If it doesn't, check the fuse and replace it if necessary, following the instructions in your charger owner's manual.

Another charger failure can be the timer switch, preventing the batteries from being charged the total time required. For this type of problem a serviceman may be needed.

If all plugs were connected and the charger is functioning properly, the next step is to check your batteries.

Using a voltmeter, first check the battery voltage with the charger on. It should read 40V or more. Then read the voltage across the CURTIS gage terminals. If the reading is significantly lower than that of the batteries, check the wires and connections between the batteries and the CURTIS. You may have a break or loose connection.

If, at the CURTIS gage terminals, the voltage is the same as the batteries, the CURTIS may have gone out of calibration and, if under warranty, should be returned for exchange.

FAST RUNDOWN

Though batteries can have their proper voltage readings, they can have lost capacity due to age or abuse. In these cases, the CURTIS runs down at a faster rate, accurately tracking the battery system's lessened capacity. In a way, the CURTIS lets you know when you need new batteries.

With new batteries, however, fast rundown is a sign of some type of battery failure or wiring/connection problem or golf car electrical component trouble. The golf car should be used until the "Empty" alarm of the CURTIS comes on. At that time, the battery voltage should be checked with a voltmeter while the car is driven. Total battery voltage at the Empty alarm should be 32.1 volts or lower. If the voltage is significantly higher, the CURTIS is malfunctioning and, if under warranty, should be returned for exchange.

However, if the voltage of the batteries is 32.1 volts or lower, each battery should be checked for bad cells and, if located, corrective action should be taken.

If the batteries check out okay and no bad cells are found, wiring and connections throughout the vehicle should be checked for poor contacts. A poor contact could permit a sizeable voltage drop, affecting the whole system. Or, an electrical component could be drawing excessive current.

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CURTIS INSTRUMENTS, INC.

200 KISCO AVENUE, MT. KISCO, N.Y. 10549

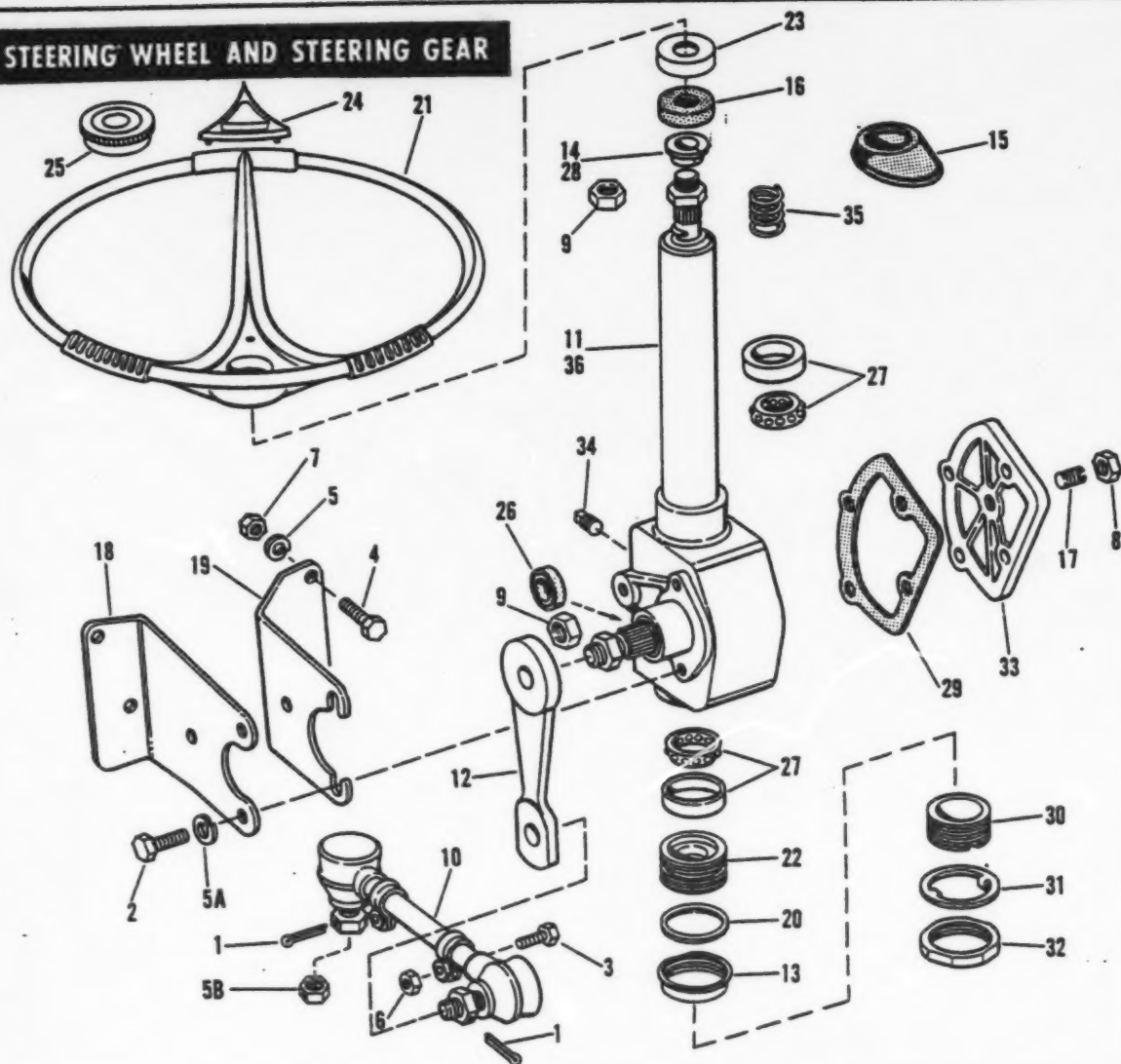
TEL. (914) 666-2971

Parts: Mechanical

Steering

(Harley Davidson/Yamaha)

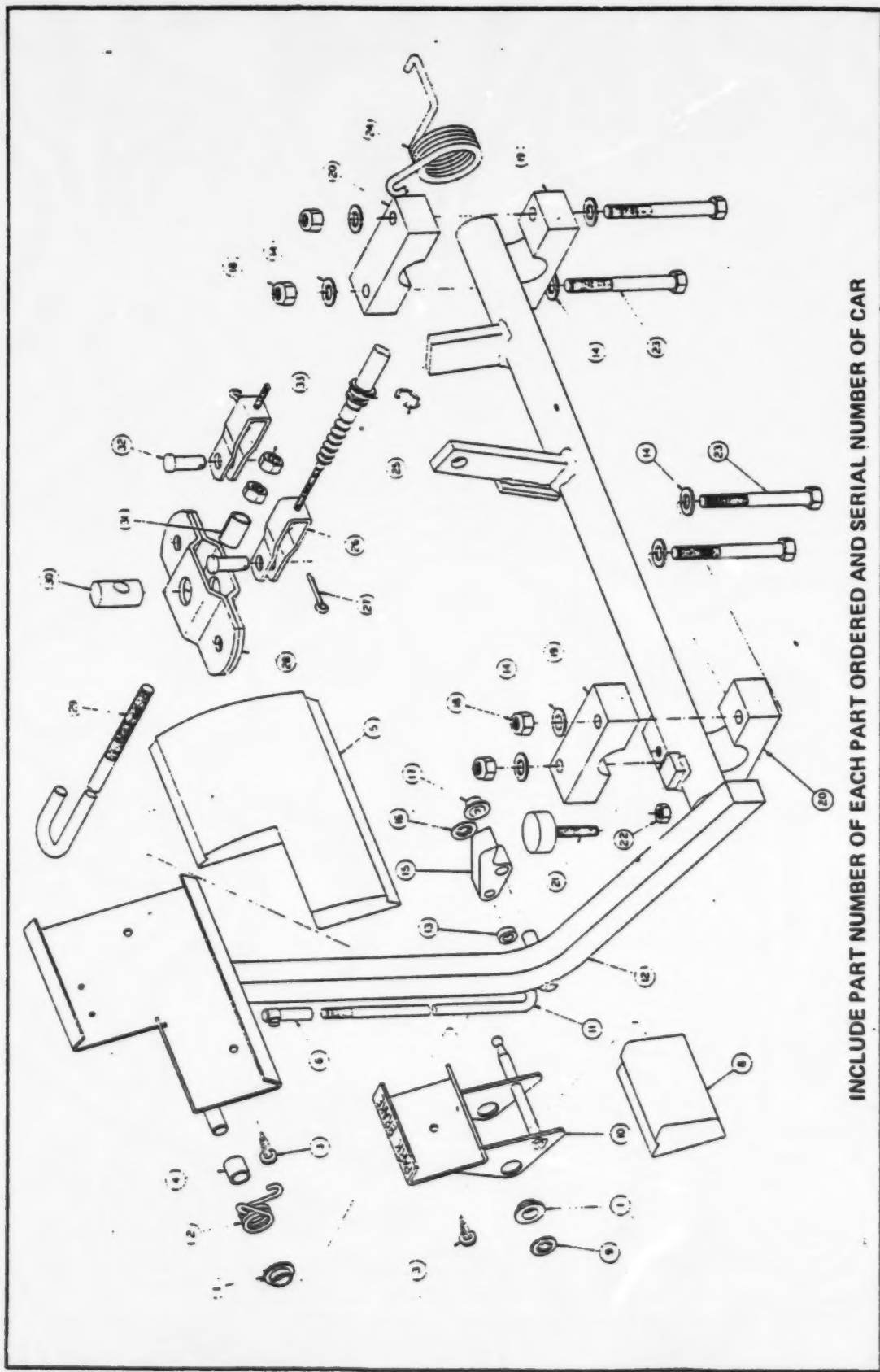
STEERING WHEEL AND STEERING GEAR



HARLEY DAVIDSON 1973

Pedal Assembly

(Club Car)



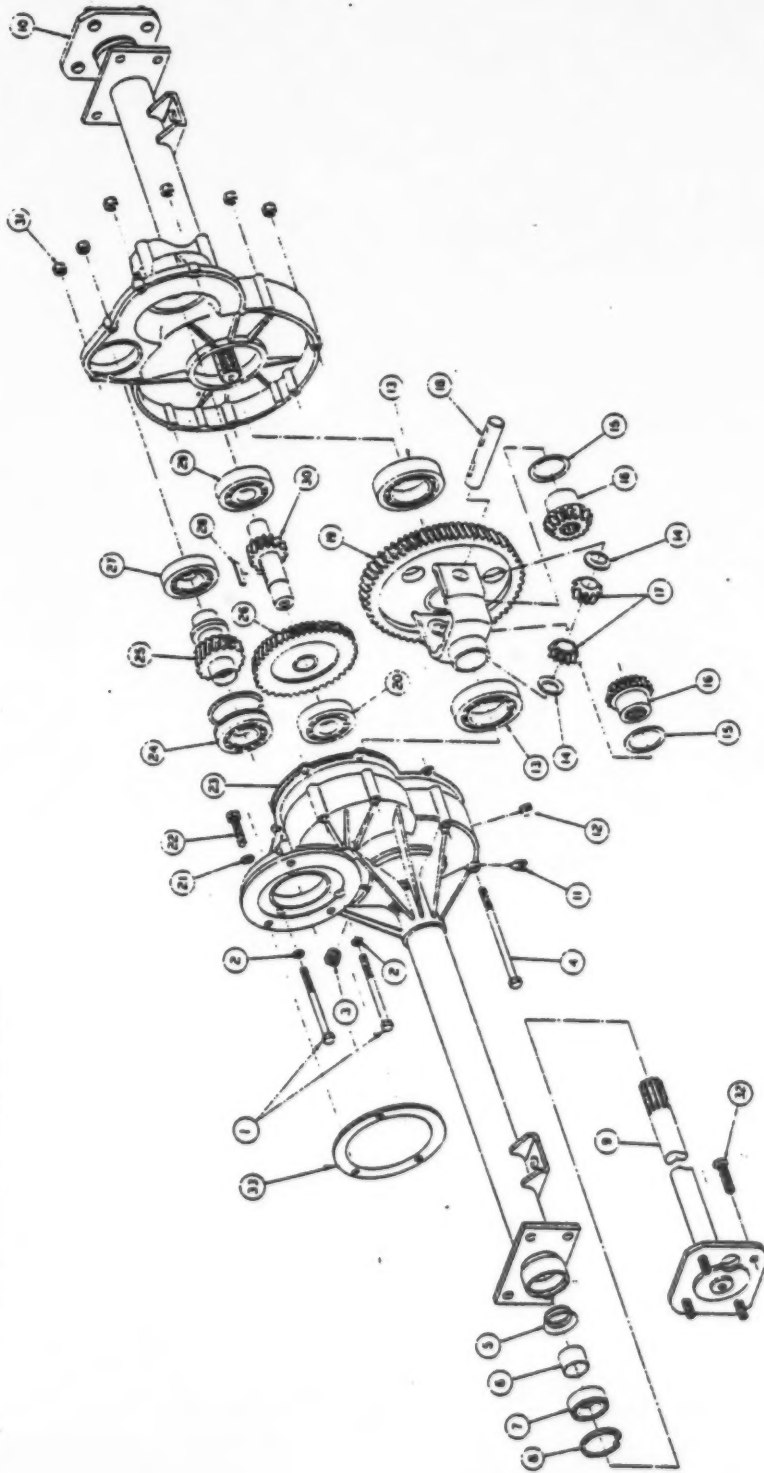
INCLUDE PART NUMBER OF EACH PART ORDERED AND SERIAL NUMBER OF CAR

Drive Unit

Brakes

(Club Car)

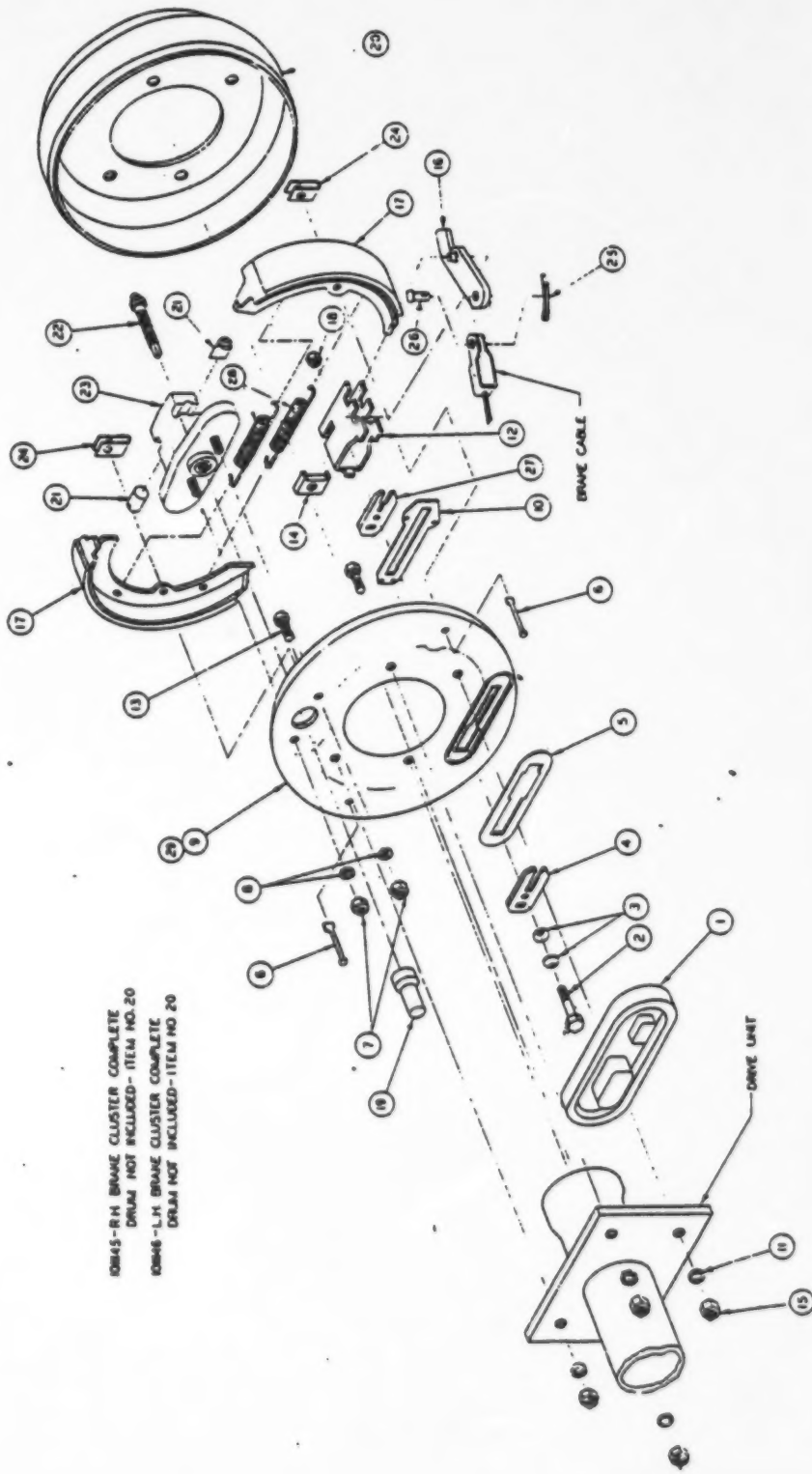
OM641-DRIVE UNIT ASS'Y (12/1) AXLES NOT INCLUDED



INCLUDE PART NUMBER OF EACH PART ORDERED AND SERIAL NUMBER OF CAR

Issue Date 8/1/83

Effective Serial No. A8036-15260 thru A8405-50906



10245-RH BRAKE CLUSTER COMPLETE
 DRUM NOT INCLUDED- ITEM NO.20
 10245-LH BRAKE CLUSTER COMPLETE
 DRUM NOT INCLUDED-ITEM NO.20

INCLUDE PART NUMBER OF EACH PART ORDERED AND SERIAL NUMBER OF CAR.